

US.Pat.Apl.No:10-662,818

Docket 616-76US

**Amendments to Claims**

submitted July 2006

Claims now amended: 1,2,8,10,11,13,14.

Claims now cancelled: 5-7,9,12.

New claims now added: 15-27.

Preferred order of claims as now presented:

1,15-21,2-4,22,8,23-24,10,25,11,26-27.

Clm 1 (currently amended). Apparatus for diminishing the concentration of ammonium in waste-water, and for disposing of the ammonium as nitrogen gas, wherein:

- [2] the apparatus includes an ammonium-extraction station, which:-
- [3] - includes a waste-water entry port, for receiving a stream of the waste-water to be treated;
- [4] - is operable to extract ammonium out of solution from the waste-water stream;
- [5] - includes a treated-water discharge port, for discharging the waste-water stream, now with its dissolved ammonium content reduced, from the apparatus;
- [6] the apparatus includes a body of secondary-water;
- [7] the apparatus includes a secondary-water circuit, comprising water-containment components, which contain the body of secondary-water;
- [8] the apparatus includes an ammonium-transfer station, which is one of the water-containment components of the secondary-water circuit, and which is operable to receive the ammonium extracted from the ammonium-extraction station, and to transfer same into the body of secondary water;  
~~[the ammonium extraction and transfer station is operable to transfer the ammonium extracted from the stream of waste water into solution in the body of secondary water,]~~
- [9] the apparatus includes an electrolysis station, which is one of

the components of the secondary-water circuit;

~~[the secondary-water circuit is operable to convey the secondary-water between the ammonium-transfer station and the electrolysis station,]~~

- [10] the electrolysis station includes an electrolytic cell, which is operable upon being supplied with electrical energy:-
- [11] - to electrolyse the secondary-water, and to oxidise the ammonium dissolved therein;
- [12] - to thermodynamically favour the transformation of the nitrogen component thereof to nitrogen gas;
- [13] the apparatus includes a nitrogen-discharge port, for discharging the resulting nitrogen gas from the electrolysis station;
- [14] the apparatus includes an intermediate tank, which is one of the water-containment components of the secondary-water-circuit;
- [15] the ammonium-transfer station has an ammonium-station-inlet and an ammonium-station-outlet, through which secondary-water respectively enters and leaves the ammonium-transfer station;
- [16] the electrolysis station has an electrolysis-station-inlet and an electrolysis-station-outlet, through which secondary-water enters and leaves the electrolysis-station;
- [17] the ammonium-transfer station is so configured that secondary-water in the ammonium-station-outlet is at a higher concentration of dissolved ammonium than secondary-water in the ammonium-station-inlet;
- [18] the electrolysis station has an electrolysis-station-inlet and an electrolysis-station-outlet, through which secondary-water respectively enters and leaves the electrolysis-station;
- [19] the electrolysis station is so configured that secondary water in the electrolysis-station-outlet is at a lower concentration of dissolved ammonium than secondary-water in the electrolysis-station-inlet;
- [20] the secondary-water circuit includes respective conduits that convey secondary water:-
- [21] - from the ammonium-station-outlet into the intermediate tank;

- [22] - from the intermediate tank into the ammonium-station-inlet;  
[23] - from the electrolysis-station-outlet into the intermediate  
tank; and  
[24] - from the intermediate tank into the electrolysis-station-inlet.

Clm 2 (original). Apparatus of claim 1, wherein the stream of waste-water being treated passes through the apparatus, and is discharged, without itself being subjected to electrolysis.

Clm 3 (original). Apparatus of claim 1, wherein the stream of waste-water being treated passes through the apparatus, and is discharged, without touching the body of secondary-water.

Clm 4 (currently amended). Apparatus of claim 1, wherein the apparatus is operable to circulate and recirculate the body of secondary-water through [and between the ammonium-extraction-and-transfer-and] the electrolysis station, and the apparatus is operable to perform the electrolysis periodically, while the body of secondary-water is recirculating through the ammonium-transfer station.

Clms 5,6,7. (cancel)

Clm 8 (currently amended). Apparatus of [~~claim 7,~~] claim 22, wherein the secondary-water circuit is operable to recirculate the regenerant-water through the sorbent-container and the electrolytic cell.

Clm 9. (cancel)

Clm 10 (currently amended). Apparatus of [~~claim 9]~~ claim 24, wherein the secondary-water circuit is operable to recirculate the acid-water through the acid-station and the electrolytic cell.

Clm 11 (currently amended). Water treatment plant, for treating both a lower-flowrate stream of higher-concentration waste-water and a higher-flowrate stream of lower-concentration waste-water, wherein:

- [2] the plant is operable to pass the lower-concentration stream through the ion-exchange station of ~~[claim 7]~~ claim 22, and the higher-concentration stream through the alkali-acid station of ~~[claim 9]~~ claim 24;
- [3] and the plant is operable to mix the treated waste-water effluent from the alkali-acid station with the waste-water stream entering and passing through the ion-exchange station.

Clm 12 (cancel)

Clm 13 (currently amended). The use of the apparatus of claim 1 to ~~[reduce]~~ oxidise ammonium to nitrogen gas.

Clm 14 (currently amended). The use of the procedure of ~~[claim 12]~~ claim 27 to ~~[reduce]~~ oxidise ammonium to nitrogen gas.

Clm 15 (new). Apparatus of claim 1, wherein the apparatus includes means for adjusting the pH level of secondary-water residing in the intermediate tank.

Clm 16 (new). Apparatus of claim 1, wherein the apparatus includes means for ensuring that secondary-water residing in the intermediate tank is mixed.

Clm 17 (new). Apparatus of claim 16, wherein the means for ensuring that secondary-water residing in the intermediate tank is mixed comprises an operable powered mixer, which is effective, when operated, to mechanically stir secondary-water residing in the intermediate-tank.

Clm 18 (new). Apparatus of claim 1, wherein the ammonium concentration of secondary-water entering the ammonium-station through the ammonium-station-inlet is substantially the same as the ammonium concentration of secondary-water entering the electrolysis-station through the electrolysis-station-inlet.

Clm 19 (new). Apparatus of claim 1, wherein the pH of secondary-water entering the ammonium-station through the ammonium-station-inlet is substantially the same as the pH of secondary-water entering the electrolysis-station through the electrolysis-station-inlet.

Clm 20 (new). Apparatus of claim 1, wherein the said respective conduits that convey secondary water:-

- [2] - from the ammonium-station-outlet into the intermediate tank;
- [3] - from the intermediate tank into the ammonium-station-inlet;
- [4] - from the electrolysis-station-outlet into the intermediate tank; and
- [5] - from the intermediate tank into the electrolysis-station-inlet;
- [6] are effective to so convey the secondary-water directly, in the sense that the secondary-water undergoes no substantial change of ammonium concentration therebetween.

Clm 21 (new). Apparatus of claim 1, wherein the said respective conduits that convey secondary water:-

- [2] - from the ammonium-station-outlet into the intermediate tank;
- [3] - from the intermediate tank into the ammonium-station-inlet;
- [4] - from the electrolysis-station-outlet into the intermediate tank; and
- [5] - from the intermediate tank into the electrolysis-station-inlet;
- [6] are effective to so convey the secondary-water directly, in the sense that the secondary-water undergoes no substantial change of pH level while being conveyed therebetween.

Clm 22 (new). Apparatus of claim 1, wherein:

- [2] an ion-exchange station of the apparatus combines the ammonium-extraction station and the ammonium-transfer station;
- [3] the ion-exchange station includes a sorbent-container, in which is contained a sorbent-body, which is effective to sorb ammonium from water passing therethrough;
- [4] the secondary-water comprises regenerant-water, being water that contains, in solution, a regenerant-substance, which is of such nature, and of such concentration, as to have an ion-exchange relationship with respect to ammonium ions sorbed onto the sorbent-body;
- [5] the ion-exchange station includes connecting conduits and operable flow-control valves therein;
- [6] the valves are operable to set the ion-exchange station into a sorption-mode and are operable to set the ion-exchange station into a regenerant-mode;
- [7] in the sorption-mode, the valves and conduits are arranged so that waste-water passes from the waste-water entry port, through the sorbent-container, and out of the treated-water discharge port; and
- [8] in the regenerant-mode, the valves and conduits are included in the secondary-water circuit, in which the regenerant-water, having passed through the sorbent-container, passes then through the electrolytic cell.

Clm 23 (new). Apparatus of claim 22, wherein the body of secondary-water is, or includes, brine.

Clm 24 (new). Apparatus of claim 1, wherein:-

- [2] an alkali-acid station of the apparatus combines the ammonium-extraction station and the ammonium-transfer station;
- [3] the body of secondary-water comprises a body of acid-water;
- [4] the alkali-acid station includes:
- [5] - a means for elevating the pH of ammonium-laden waste-water

- entering the waste-water entry port to at least ten;
- [6] - an alkali-station, comprising a waste-water conduit containing the alkaline waste-water and a gas conduit, and the alkali-station is so structured that ammonia gas emanating from the alkaline waste-water in the waste-water conduit is captured and carried away in the gas conduit;
  - [7] - a means for maintaining the pH of the acid-water at no more than four;
  - [8] - an acid-station, which includes the gas conduit and an acid-water conduit containing the acid-water, and the acid-station is so structured that ammonia gas contained in the gas conduit is taken into solution in the acid-water in the acid-water conduit;
  - [9] and the secondary-water circuit includes the acid-water conduit, in which the acid-water, having passed through the acid-station, passes then through the electrolytic cell.

Clm 25 (new). Apparatus of claim 24, wherein the body of secondary water is, or includes, hydrochloric acid.

Clm 26 (new). Apparatus for diminishing the concentration of ammonium in a body of secondary-water, and for disposing of the ammonium as nitrogen gas, wherein:

- [2] the apparatus includes a body of secondary-water;
- [3] the apparatus includes a secondary-water circuit, comprising water-containment components, which contain the body of secondary-water;
- [4] the apparatus includes an ammonium station, which is one of the components of the secondary-water circuit;
- [5] the apparatus is so arranged that ammonium is added to secondary-water passing through the ammonium station;
- [6] the apparatus includes an electrolysis station, which is one of the components of the secondary-water circuit ;
- [7] the electrolysis station includes an electrolytic cell, which is

operable upon being supplied with electrical energy:-

- [8] - to electrolyse the secondary-water, and to oxidise the ammonium dissolved therein;
- [9] - to thermodynamically favour the transformation of the nitrogen component thereof to nitrogen gas;
- [10] the apparatus includes a nitrogen-discharge port, for discharging the resulting nitrogen gas from the electrolysis station;
- [11] the apparatus includes an intermediate tank, which is one of the components of the secondary-water-circuit;
- [12] the ammonium station has an ammonium-station-inlet and an ammonium-station-outlet, through which secondary-water respectively enters and leaves the ammonium-station;
- [13] the electrolysis station has an electrolysis-station-inlet and an electrolysis-station-outlet, through which secondary-water enters and leaves the electrolysis-station;
- [14] the ammonium station is so configured that secondary-water in the ammonium-station-outlet is at a higher concentration of dissolved ammonium than secondary-water in the ammonium-station-inlet;
- [15] the electrolysis station has an electrolysis-station-inlet and an electrolysis-station-outlet, through which secondary-water respectively enters and leaves the electrolysis-station;
- [16] the electrolysis station is so configured that secondary water in the electrolysis-station-outlet is at a lower concentration of dissolved ammonium than secondary-water in the electrolysis-station-inlet;
- [17] the secondary-water circuit includes respective conduits that convey secondary water:-
- [18] - from the ammonium-station-outlet into the intermediate tank;
- [19] - from the intermediate tank into the ammonium-station-inlet;
- [20] - from the electrolysis-station-outlet into the intermediate tank; and
- [21] - from the intermediate tank into the electrolysis-station-inlet.



Clm 27 (new). Procedure including:

- [2] providing the apparatus of claim 1;
- [3] operating same to diminish the concentration of ammonium in the body of secondary-water, including adding pH-altering chemicals to the intermediate tank, as required.